Study of the effect of AVAS on road traffic noise

JASIC
Contents

➢ Calculation flow of road traffic noise

➢ Effect of the increase of EV

➢ Influence of the installation of AVAS
Calculation flow of JARI model \[^{[1],[2],[3]}\]

1. Estimation of traffic flow
2. Running condition of each vehicle
3. Power unit noise
4. Tire/road noise
5. Sound Power level of each vehicle
6. Sound propagation
7. Calculation of $L_{Aeq}$

- Tire/road noise
- Power unit noise
- Running condition of each vehicle
- Estimation of traffic flow
Traffic flow simulation

Running condition (speed, acceleration, engine speed, position) of each vehicle is estimated.
Calculation flow of JARI model [1], [2], [3]

1. Estimation of traffic flow
2. Running condition of each vehicle
3. Power unit noise
4. Tire/road noise
5. Sound Power level of each vehicle
6. Sound propagation
7. Calculation of $L_{Aeq}$
## Sound power level model of ICE vehicle

<table>
<thead>
<tr>
<th>Noise sources</th>
<th>Models</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Power unit noise</strong></td>
<td>[ L_{WE} = A_0 + A_1 \log \frac{S}{S_0} + A_2 L ]</td>
</tr>
<tr>
<td></td>
<td>( S ) : Engine speed [rpm], ( L ) : Engine load [%]</td>
</tr>
<tr>
<td><strong>Tire/road noise</strong></td>
<td>[ L_{WT} = C_0 + C_1 \log \frac{V}{V_0} ]</td>
</tr>
<tr>
<td></td>
<td>( V ) : Vehicle speed [km/h]</td>
</tr>
</tbody>
</table>
Calculation flow of JARI model [1], [2], [3]

1. Estimation of traffic flow
2. Running condition of each vehicle
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4. Tire/road noise
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7. Calculation of $L_{Aeq}$
Time history of road traffic noise

Measured

Calculated
Comparison of measured and calculated $L_{Aeq}$
Aural simulation of road traffic noise \[4\]

Estimation of traffic flow

Running condition of each vehicle

Synthesis of sound waveforms

Power unit noise
Tire/road noise

Sound pressure waveform of each vehicle

Sound propagation

Synthesized waveform of road traffic noise
Waveforms from noise sources of ICE vehicle

<table>
<thead>
<tr>
<th>Noise sources</th>
<th>Sound pressure waveforms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power unit noise</td>
<td>![Waveform for Power unit noise]</td>
</tr>
<tr>
<td>Tire/road noise</td>
<td>![Waveform for Tire/road noise]</td>
</tr>
</tbody>
</table>
Visual and aural simulation [4]
Contents

- Calculation flow of road traffic noise
- Effect of the increase of EV
- Influence of the installation of AVAS
### Noise radiation of EV

<table>
<thead>
<tr>
<th>Noise sources</th>
<th>Noise radiations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power unit noise</td>
<td>Not radiated</td>
</tr>
<tr>
<td>Tire/road noise</td>
<td>Radiated same as ICE vehicle</td>
</tr>
</tbody>
</table>
Prediction area(1): Urban area

Traffic volume: 1,434 vehicles/hour
Speed limit: 50 km/h

Ratio of vehicle categories:
- Passenger car: 85.9%
- Light truck: 5.1%
- Medium truck: 5.7%
- Heavy truck: 0.6%
- Motorcycle: 2.7%

Traffic conditions
- Prediction point far from intersection
- Prediction point near intersection with traffic light
Prediction results in urban area: Effect of the increase of EV [5]

<table>
<thead>
<tr>
<th>Ratio of EV (in passenger car) [%]</th>
<th>Near intersection</th>
<th>Far from intersection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$L_{Aeq}$ [dB]</td>
<td>Decrease [dB]</td>
</tr>
<tr>
<td>0</td>
<td>70.3</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>70.1</td>
<td>0.2</td>
</tr>
<tr>
<td>40</td>
<td>70.0</td>
<td>0.3</td>
</tr>
</tbody>
</table>

When EVs increase to 40 %, it is predicted that road traffic noise $L_{Aeq}$ in urban area decreases 0.2 dB to 0.3 dB.
Prediction area(2): Residential area

Traffic conditions
- Traffic volume: 60 vehicles/hour
- Ratio of vehicle categories:
  - Passenger car: 100%
  - Light truck: 0%
  - Medium truck: 0%
  - Heavy truck: 0%
  - Motorcycle: 0%
- Speed limit: 30 km/h

Prediction point far from intersection
Prediction point near intersection
When EVs increase to 40 %, it is predicted that road traffic noise $L_{Aeq}$ in residential area decreases 1.3 dB to 1.9 dB.

<table>
<thead>
<tr>
<th>Ratio of EV (in passenger car) [%]</th>
<th>Near intersection</th>
<th>Far from intersection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$L_{Aeq}$ [dB]</td>
<td>Decrease [dB]</td>
</tr>
<tr>
<td>0</td>
<td>55.2</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>54.2</td>
<td>1.0</td>
</tr>
<tr>
<td>40</td>
<td>53.3</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Prediction results in residential area: Effect of the increase of EV [5]
Contents

- Calculation flow of road traffic noise
- Effect of the increase of EV
- Influence of the installation of AVAS
### Sound radiation from EV with AVAS

<table>
<thead>
<tr>
<th>Sound sources</th>
<th>Sound radiations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power unit → AVAS</td>
<td>Type: Continuous sound</td>
</tr>
<tr>
<td></td>
<td>Level: 50 dB(A) at 2 m forward of vehicle, 1.2 m in height</td>
</tr>
<tr>
<td></td>
<td>(Constant level, equals to idling of ICE vehicle)</td>
</tr>
<tr>
<td></td>
<td>Speed range in which sound is generated:</td>
</tr>
<tr>
<td></td>
<td>0 &lt; Speed ≤ 20 km/h</td>
</tr>
<tr>
<td>Tire/road noise</td>
<td>Same as ICE vehicle</td>
</tr>
</tbody>
</table>
Prediction results: Influence of the installation of AVAS \[5\]

<table>
<thead>
<tr>
<th>Ratio of EV (in passenger car) [%]</th>
<th>Residential area</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Near intersection</td>
<td>Far from intersection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>$L_{Aeq}$ [dB]</td>
<td>Decrease [dB]</td>
<td>$L_{Aeq}$ [dB]</td>
</tr>
<tr>
<td></td>
<td>Without AVAS</td>
<td>With AVAS</td>
<td>Without AVAS</td>
</tr>
<tr>
<td>0</td>
<td>55.2</td>
<td></td>
<td>54.2</td>
</tr>
<tr>
<td>20</td>
<td>54.2</td>
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<tr>
<td>40</td>
<td>53.3</td>
<td>1.9</td>
<td>1.9</td>
</tr>
</tbody>
</table>

Even if AVAS is installed in EV, it doesn't influence road traffic noise.
Conclusion

- When EVs increase to 40 %, it is predicted that road traffic noise $L_{Aeq}$ in urban area decreases 0.2 dB to 0.3 dB, and $L_{Aeq}$ in residential area decreases 1.3 dB to 1.9 dB.

- The effect of AVAS installed in EV was examined, where the sound was generated at the same level as idling of ICE vehicle in the speed range in 20 km/h or less. As a result, it has been found that the sound from AVAS doesn't influence road traffic noise.
Reference


Thank you